

# Aide-memoire for Prevention of Freeze Damage to Vaccines

Cold-chain storage is necessary to prevent damage to vaccines caused by heat exposure. However, some vaccines may be damaged by freezing them below 0°C. As a result, the vaccine's effectiveness can be diminished and the risk of adverse events following immunization—such as sterile abscesses—may increase.

Although reports from many countries document inadvertent freezing temperatures at all levels of the cold chain, protecting vaccines from freeze damage remains one of the most poorly addressed problems in vaccine management. Using freeze-damaged vaccines will make it harder to achieve disease-prevention goals. The cost associated with wastage of vaccines damaged by freezing is high and increases with the introduction of expensive, freeze-sensitive combination vaccines.

Studies conducted in several diverse countries demonstrate frequent occurrences of sub-zero temperatures in the cold chain. Health workers and cold-chain managers are often unaware of how vaccine freezing occurs and the significance of its consequences.

The most common cause of exposure to freezing temperatures is improper use of ice packs prior to transport. The practice of immediately placing deep-frozen ice packs, which can reach temperatures as low as -20°C, in well-insulated cold boxes places freeze-sensitive vaccines at the greatest risk.<sup>1</sup> Other common causes of vaccine freezing include:

- Cold rooms or refrigerator thermostats that are adjusted improperly;
- Vaccines that are incorrectly positioned in cold rooms or refrigerators;
- Inadequate temperature monitoring of cold chain equipment.

To reduce the risk of freeze damage to vaccines, programmes should follow the best practices outlined in this aide-memoire, increase awareness about the issue, and implement clear operational guidelines and training for staff working at all levels of the cold chain. A study protocol is available from WHO for national programmes to assess the extent of the vaccine-freezing problem in their cold chain systems and to implement corrective measures when necessary.<sup>1</sup>

## How to Prevent Freeze Damage

### 1. During domestic transport to the health facility:

Do not load cold boxes or vaccine carriers with deeply frozen ice packs, and always use a freeze indicator in the transport container. Be aware that vaccine vials are not adequately protected from freezing if wrapped with newspaper or cardboard. Therefore, apply the following options where appropriate:

- **Properly condition ice packs:** Remove ice packs from the freezer and let them defrost at room temperature. Shake frequently until you can hear water inside the pack, and then place in the cold box. For more information, see *Immunization in Practice*, 2004 Update, Module 3 (WHO/IVB/04.06), page 19: [www.who.int/vaccines-documents/iip/PDF/Module3.pdf](http://www.who.int/vaccines-documents/iip/PDF/Module3.pdf)
- **Use cool-water packs instead of ice packs:** Cool-water packs will keep vaccines safe during distribution in most weather conditions. Cool-water packs are regular packs filled with

<sup>3</sup> Study protocol for temperature monitoring in the vaccine cold chain, WHO/IVB/05.01

water and cooled in a refrigerator. Note: If vaccine vial monitors (VVMs) are not available on oral poliovirus vaccine (OPV), transport OPV separately with frozen ice packs and freeze-sensitive vaccines with cool-water packs.

- **Use no ice packs:** Vaccines with VVMs can be used without ice packs in certain settings and with proper training. For more information, see *Getting started with vaccine vial monitors* (WHO/V&B/02.35): [www.who.int/vaccines-documents/DocsPDF02/www716.pdf](http://www.who.int/vaccines-documents/DocsPDF02/www716.pdf)

### 2. In vaccine cold rooms:

- Keep temperatures between 2°C and 8°C at all times. Set the thermostat to maintain a generally consistent temperature of 5°C.
- Check and record temperatures at least twice every 24 hours. Monitor temperatures seven days a week.
- Do not store vaccines in front of the refrigeration cold air stream. Remove or close-off shelving in this zone.
- Do not store freeze-sensitive vaccines on or within 20 centimeters of the floor.
- Place thermometers and freeze indicators at several locations in the cold room, including the highest and lowest vaccine storage points.

### 3. In refrigerators:

- Check and record temperatures at least twice every 24 hours. Monitor temperature seven days a week.
- Put a freeze indicator in every refrigerator at the level where freeze-sensitive vaccines are stored.
- Place the thermometer in the coldest part of the refrigerator: at the bottom of top-loading chest refrigerators and close to the evaporator in upright models.
- Place freeze-sensitive vaccines at least 5 centimeters away from the evaporator.
- Do not adjust the thermostats after an electricity outage or if it is believed that the vaccines need a burst of cold air.
- Set the thermostats at 5°C in the morning and then seal the thermostat in place with tape,

## Vaccines damaged by freezing are:<sup>2</sup>

- Diphtheria toxoid
- Hepatitis A
- Hepatitis B
- Influenza
- Liquid Hib conjugate
- Pertussis
- Pneumococcal conjugate
- Poliovirus (inactivated)
- Tetanus toxoid
- Typhoid (inactivated)
- Combinations containing these vaccines.

*In addition, vaccine diluents should not be frozen as the ampoules may crack or break.*

<sup>1</sup> WHO is further evaluating the recommendation to use conditioned ice packs during domestic transport and continues to explore best practice alternatives to preserve the quality of all temperature-sensitive vaccines.

<sup>2</sup> Temperature sensitivity of vaccines, WHO/IVB/06.10

## What to do if freezing occurs?

- Report evidence of freezing to supervisors for corrective action.
- If a freeze-sensitive vaccine is frozen solid, discard it immediately.
- If an indicator signals that freezing has occurred, immediately conduct the shake test on a sample of all affected vials. For guidance on conducting the shake test, see *Temperature sensitivity of vaccines* (WHO/IVB/06.10): [www.who.int/vaccines-documents/DocsPDF06/847.pdf](http://www.who.int/vaccines-documents/DocsPDF06/847.pdf).
- If freezing problems are detected, consult with experts to minimize the impact on the disease control objectives.

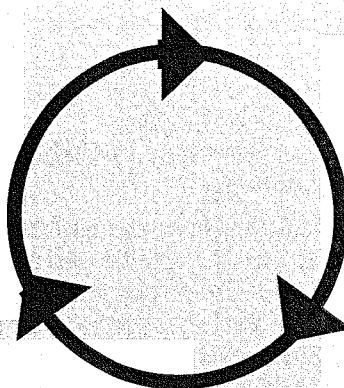
## Actions to Prevent Freezing:

### Collect and analyse the evidence

Record temperatures during storage and transport and ensure regular supervision. Conduct periodic assessments in all countries as recommended in *Study protocol for temperature monitoring in the vaccine cold chain* (WHO/IVB/05.01): [www.who.int/vaccines-documents/DocsPDF05/795.pdf](http://www.who.int/vaccines-documents/DocsPDF05/795.pdf)

### Increase awareness

All immunization programme staff need to understand that vaccine freezing is a common occurrence that, if it occurs, may damage the vaccines. Provide education and training materials to immunization program staff to increase awareness about inadvertent vaccine freezing, potential damage to vaccines, and proper vaccine management at all levels of the cold chain.



### Implement best practices

Follow the guidelines outlined in this aide-memoire to help prevent vaccine freezing in cold rooms, refrigerators, and cold climates. Most of these preventive measures are straightforward and inexpensive. Training and supportive supervision are also critical to ensuring that freeze prevention remains a high priority and that best practices are implemented. Additional information about the proper use and maintenance of cold chain equipment is available in *Immunization in Practice*, 2004 Update, Module 3 (WHO/IVB/04.06), page 19: [www.who.int/vaccines-documents/iip/PDF/Module3.pdf](http://www.who.int/vaccines-documents/iip/PDF/Module3.pdf)

even if this action results in temperature occasionally rising above 8°C.

- When ice-lined refrigerator (ILR) thermostat are adjusted properly, ice linings will not be fully frozen. In ILRs, do not store freeze-sensitive vaccines within 20 centimeters of the bottom and place freeze-sensitive vaccines in the storage baskets provided with the unit.
- Use refrigerators specifically designed for vaccine storage.<sup>1</sup>

#### 4. In cold climates:

- Keep cold rooms and vaccine refrigerators in heated rooms.
- Use room-temperature water packs for vaccine transport. Fill ordinary ice packs with tap water; do not freeze or chill them. In extremely cold conditions, use packs filled with warm water at 20°C.
- Use freeze indicators in all refrigerators and cold boxes.
- Use a heated vehicle. Never leave cold boxes in an unheated vehicle, especially overnight.

- Do not leave cold boxes outdoors, or in unheated rooms. ■

This article is adapted from a WHO Aide-memoire, which may be requested (Ordering Code: WHO/IVB/07.09) along with other materials on immunization, vaccines and biologicals from the Department of Immunization, Vaccines and Biologicals of the World Health Organization, by fax at + 41 22 791 4227 or by E-mail at [vaccines@who.int](mailto:vaccines@who.int). It can also be consulted on the web at [http://whqlibdoc.who.int/hq/2007/WHO\\_IVB\\_07.09\\_eng.pdf](http://whqlibdoc.who.int/hq/2007/WHO_IVB_07.09_eng.pdf).

<sup>1</sup> See Product Information Sheets for information, available at [http://www.who.int/immunization\\_standards/vaccine\\_quality/pis/en/index.html](http://www.who.int/immunization_standards/vaccine_quality/pis/en/index.html).

## Vaccine Freezing: Results from a Study Conducted in Bolivia

A study conducted in Bolivia (2005) monitored vaccine cold chain temperatures during routine pentavalent (DTP-HB-Hib) vaccine shipments from central stores to local health units, as well as vaccine carriers used for outreach vaccination. The authors adapted a protocol for monitoring vaccine temperatures developed by PATH and recommended by the World Health Organization (WHO).<sup>1</sup> They used miniature temperature recording devices in boxes containing the liquid

component of the pentavalent vaccine. Interestingly, the vaccines were less exposed to heat (>8°C) than to freezing, even in warm areas of Bolivia. Freezing was more common at local level storage, such as health unit and during transport to the province and district levels. Bolivia has since intensified training on cold chain and plans to conduct a follow-up assessment.

The results of this study highlight the risk of vaccine freezing, especially when considering the introduction of new, more expensive, freeze-sensitive vaccines. Health workers must be

aware of the importance of properly adjusting refrigerator thermostats, avoiding that vaccines touch the refrigerator walls, and defrosting the ice packs before packing them in cold boxes. Training and supervision are key to ensure that health care workers understand and manage cold chain concepts. Studies monitoring vaccine temperature are a useful tool to assess the situation in a given country or province. ■

#### References:

- (1) Nelson C, Froes P, Dyck AM, Chavarria J, Boda E, Coca A, Crespo G, Lima H. Monitoring temperatures in the vaccine cold chain in Bolivia. *Vaccine*. 2007;25:433-7.
- (2) Matthias DM, Robertson J, Garrison MM, Newland S, Nelson C. Freezing temperatures in the vaccine cold chain: a systematic literature review. *Vaccine*. 2007;25:3980-6.

<sup>1</sup> Available at: <http://www.who.int/vaccines-documents/DocsPDF05/795.pdf>